Proposed

Total Maximum Daily Loads

for

Dissolved Oxygen and Nutrients

in

Wolf Creek

WBID 3075

November 2012

Region 4 serving the southeast

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LIST OF ABBREVIATIONS

B-MAP	Basin Management Action Plan
BMP	Best Management Practices
BOD	Biochemical Oxygen Demand
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
CO_2	Carbon Dioxide
DO	Dissolved Oxygen
EMC	Event Mean Concentration
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FLUCCS	Florida Land Use Cover Classification System
FS	Florida Statutes
GIS	Geographic Information System
HSPF	Hydrologic Simulation Program Fortan
HUC	Hydrologic Unit Code
IWR	Impaired Surface Waters Rule
KM^2	Square Kilometers
L	Liters
L/FT^3	Liters per Cubic Foot
LA	Load Allocation
LB/YR	Pounds per year
LSPC	Loading Simulation Program C++
MDAS	Mining Data Analysis System
MGD	Million Gallons per Day
MG/L	Milligram per liter
ML	Milliliters
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer Systems
NASS	National Agriculture Statistics Service
NH_4	Ammonia Nitrogen
NHD	National Hydrography Data
NO_2	Nitrite
NO_3	Nitrate
NPDES	National Pollutant Discharge Elimination System

OBS	Observations
OSTD	Onsite Treatment and Disposal System
SCI	Stream Condition Index
SJRWMD	St. Johns River Water Management District
SOD	Sediment Oxygen Demand
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorus
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WASP	Water Quality Analysis Simulation Program
WBID	Water Body Identification
WLA	Waste Load Allocation
WQS	Water Quality Standards
WMD	Water Management District
WWTP	Waste Water Treatment Plant

SUMMARY SHEET
Total Maximum Daily Load (TMDL)

1998 303(d) Listed Waterbodies for TMDLs addressed in this report:

WBID	Segment Name	Class and Waterbody Type	Major River Basin	HUC	County	State
3075	Wolf Creek	Class III Freshwater	Upper St. Johns River	03080101	Osceola	Florida

TMDL Endpoints/Targets:

Dissolved Oxygen and Nutrients

TMDL Technical Approach:

The TMDL allocations were determined by analyzing the effects of BOD, TN, and TP loads on DO concentrations in the waterbody. A watershed model was used to predict delivery of pollutant loads to the waterbody, and a WASP Eutrophication model was used to evaluate the in-stream impacts of the pollutant loads.

TMDL Waste Load and Load Allocation

	Current Condition		TMDL Condition		MS4	LA
Constituent	WLA (kg/yr)	LA (kg/yr)	WLA (kg/yr)	LA (kg/yr)	% Reduction	% Reduction
BOD	NA	58,132	NA	34,230	NA	41%
Total Nitrogen	NA	34,062	NA	18,714	NA	45%
Total Phosphorus	NA	3,182	NA	886	NA	72%

Endangered Species Present (Yes or Blank):

USEPA Lead TMDL (USEPA or Blank): USEPA

TMDL Considers Point Source, Non-point Source, or Both: Non-point Source

Major NPDES Discharges to surface waters addressed in USEPA TMDL: NA

1. Introduction

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those water bodies that are not meeting water quality standards. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and nonpoint sources and restore and maintain the quality of their water resources (USEPA, 1991).

The Florida Department of Environmental Protection (FDEP) developed a statewide, watershed-based approach to water resource management. Under the watershed management approach, water resources are managed on the basis of natural boundaries, such as river basins, rather than political boundaries. The watershed management approach is the framework FDEP uses for implementing TMDLs. The state's 52 basins are divided into five groups and water quality is assessed in each group on a rotating five-year cycle. FDEP also established five water management districts (WMD) responsible for managing ground and surface water supplies in the counties encompassing the districts. Wolf Creek is located in the Upper St. Johns River Basin and is a Group 3 waterbody managed by the St. Johns River Water Management District (SJRWMD).

For the purpose of planning and management, the WMD divided the districts into planning units defined as either an individual primary tributary basin or a group of adjacent primary tributary basins with similar characteristics. Wolf Creek is located within the Lake Poinsett Planning Unit. These planning units contain smaller, hydrological based units called drainage basins, which are further divided by FDEP into "water segments". A water segment usually contains only one unique waterbody type (stream, lake, canal, etc.) and is about 5 square miles. Unique numbers or waterbody identification (WBIDs) numbers are assigned to each water segment. This TMDL report addresses WBID 3075 (Wolf Creek).

2. Problem Definition

To determine the status of surface water quality in Florida, three categories of data – chemistry data, biological data, and fish consumption advisories – were evaluated to determine potential impairments. The level of impairment is defined in the Identification of Impaired Surface Waters Rule (IWR), Section 62-303 of the Florida Administrative Code (FAC). The IWR is FDEP's methodology for determining whether waters should be included on the state's planning list and verified list. Potential impairments are determined by assessing whether a waterbody meets the criteria for inclusion on the planning list. Once a waterbody is on the planning list, additional data and information will be collected and examined to determine if the water should be included on the verified list.

The TMDL addressed in this document is being established pursuant to commitments made by the United States Environmental Protection Agency (USEPA) in the 1998 Consent Decree in the Florida TMDL lawsuit (Florida Wildlife Federation, et al. v. Carol Browner, et al., Civil Action No. 4: 98CV356-WS, 1998). The Consent Decree established a schedule for TMDL development for waters listed on Florida's USEPA approved 1998 section 303(d) list. The 1998 section 303(d) list identified numerous WBIDs in the Upper St. Johns River Basin as not meeting Water Quality Standards (WQS). After assessing all readily available water quality data, USEPA is responsible for developing a TMDL for WBID 3075 (Wolf Creek). The geographic location of this WBID is shown in Figure 1. The parameters addressed in this TMDL are Dissolved Oxygen and Nutrients.

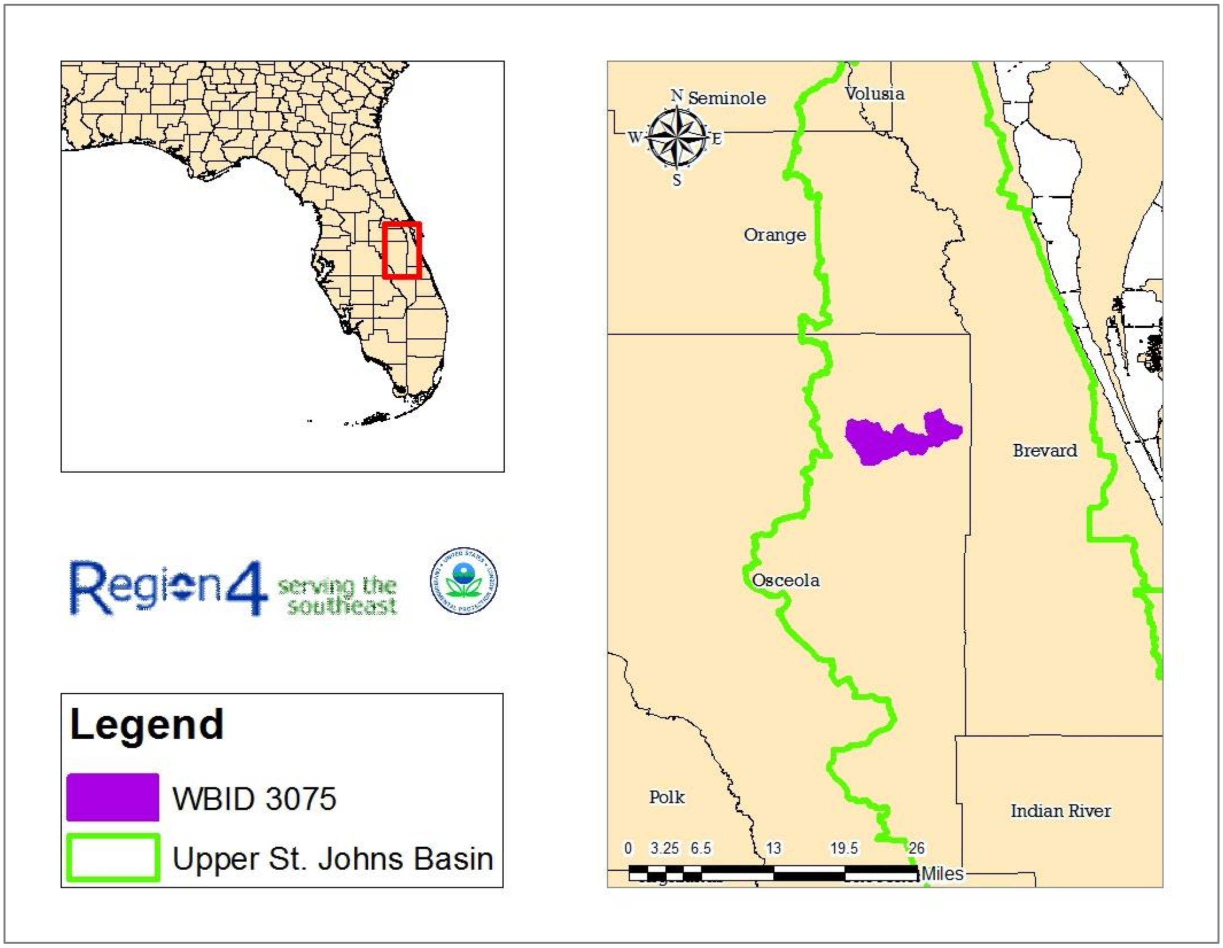

Figure 1. Location Map Wolf Creek

3. Watershed Description

The Lake Poinsett Planning Unit consists of 347 square miles and is located in Brevard, Osceola, and Orange Counties. WBID 3075, Wolf Creek, is located in the western portion of the Lake Poinsett Planning Unit, amongst extensive wetlands, and covers approximately 18 square miles (48 sq km). Wolf Creek flows east and empties into the St. Johns River just south of Lake Winder. Figure 2 depicts the delineated watershed used for analysis in this TMDL report and the location of WBID 3075within that watershed.

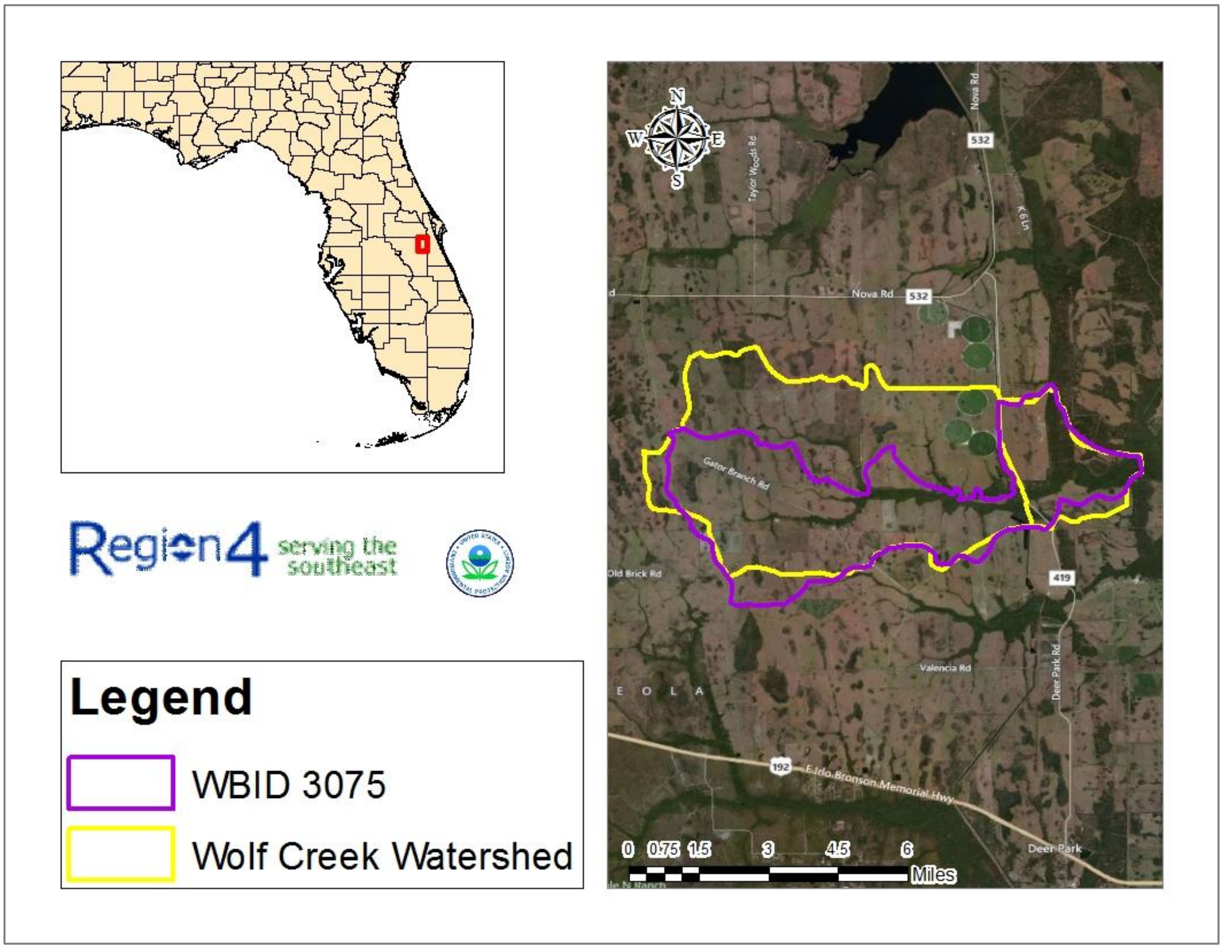

Figure 2. Wolf Creek Watershed.

In order to identify possible pollutant sources in the watershed, the latest landuse coverage was obtained from the FDEP. The landuses are based on 2009 land cover features and are classified using the Level 1 Florida Landuse Classification Code (FLUCC). As depicted in Figure 3, landuse in the Wolf Creek watershed is largely agriculture. Over 78 percent of the watershed area consists of agriculture, of which 68 percent is defined as pastureland and approximately 10 percent as cropland. The second largest landuse identified in the watershed is wetlands at 16 percent. Figure 4 provides a complete breakdown of landuse within the watershed and Figure 5 provides a breakdown of the landuse within WBID 3075.

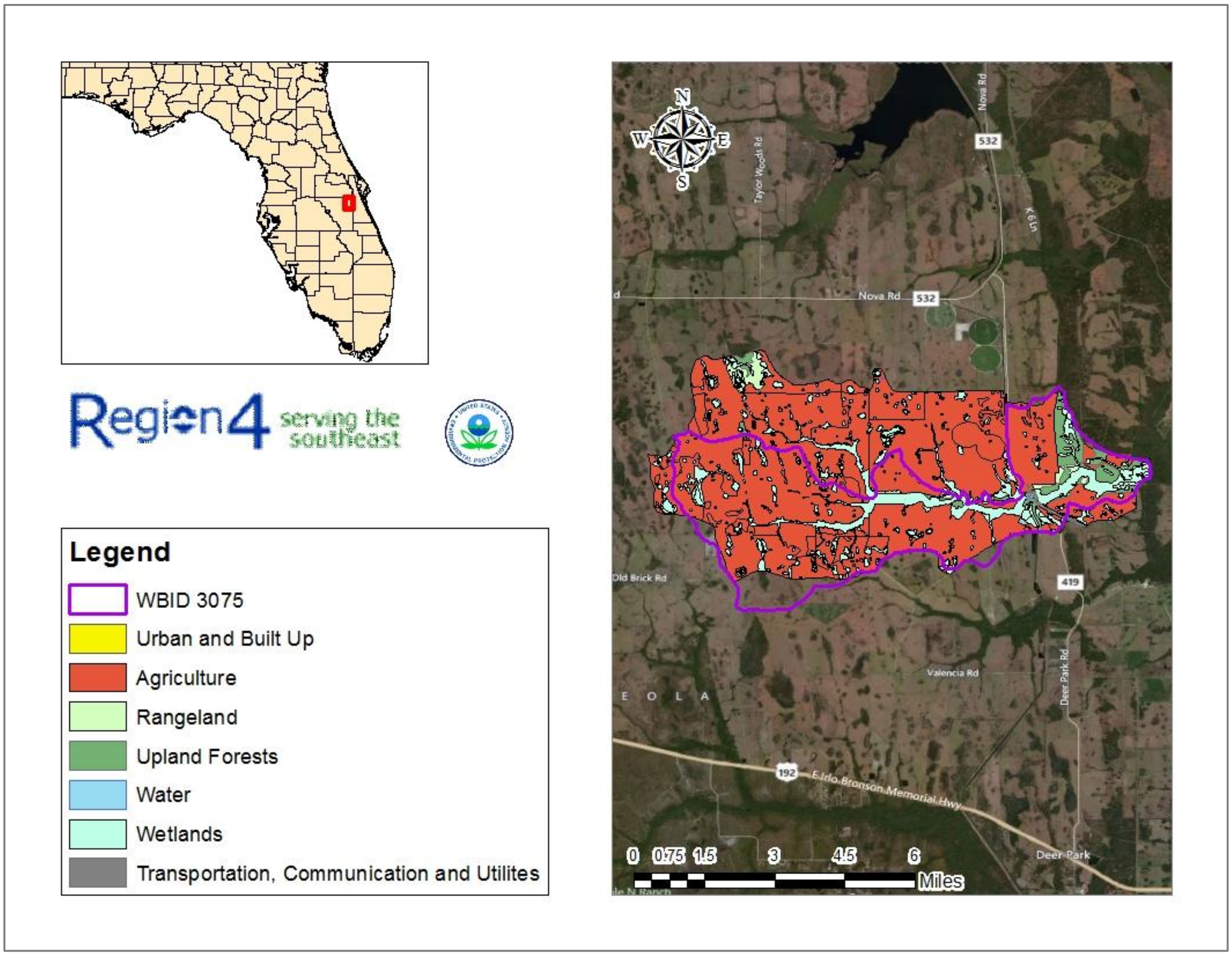

Figure 3. Landuse in the Wolf Creek Watershed

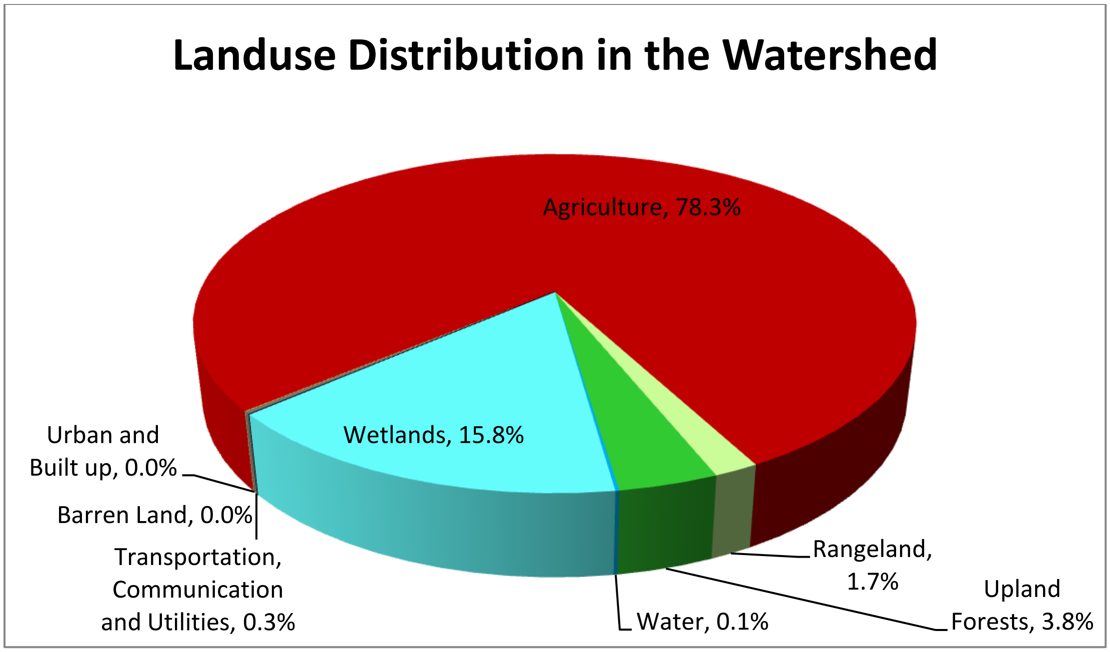

Figure 4. Landuse Distribution in Wolf Creek Watershed

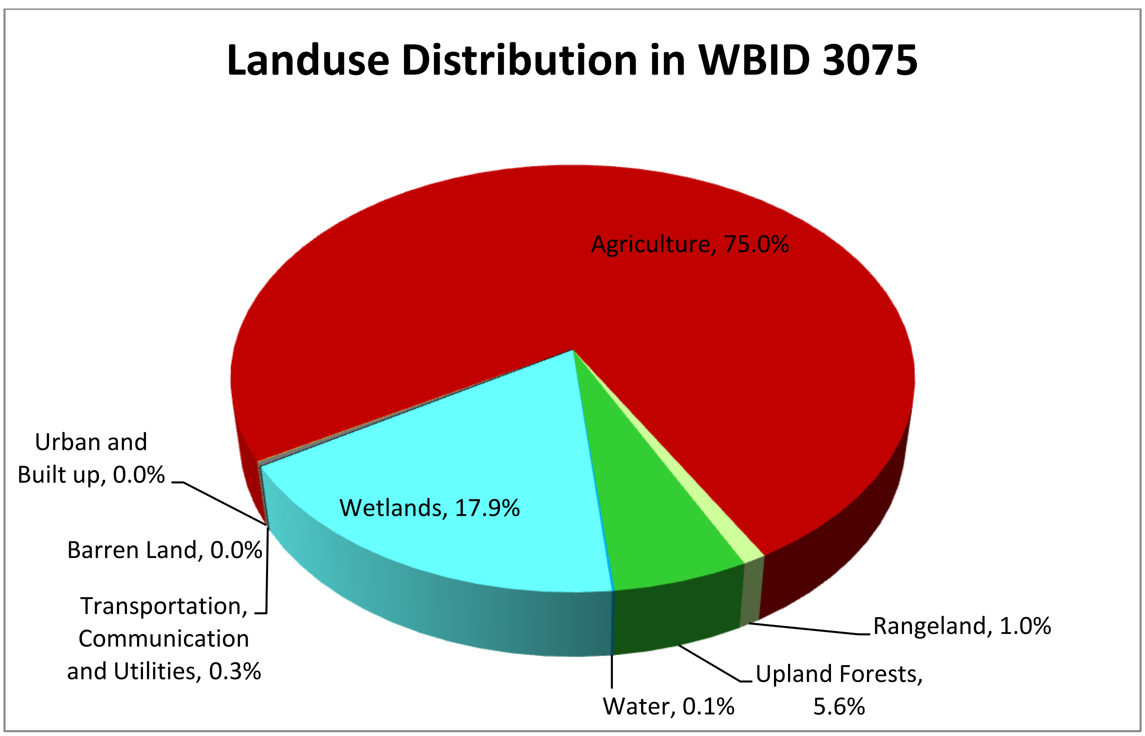

Figure 5. Landuse Distribution in Wolf Creek-WBID 3075

4. Water Quality Standards/TMDL Targets

The waterbodies in the Wolf Creek WBID are Class III Freshwater with a designated use of Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife. Designated use classifications are described in Florida's water quality standards. See Section 62-302.400, F.A.C. Water quality criteria for protection of all classes of waters are established in Section 62-302.530, F.A.C. Individual criteria should be considered in conjunction with other provisions in water quality standards, including Section 62-302.500 F.A.C., which established minimum criteria that apply to all waters unless alternative criteria are specified. Section 62-302.530, F.A.C.

4.1. Nutrients:

The designated use of Class III waters is recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. In 1979, FDEP adopted a narrative criterion for nutrients. FDEP recently adopted numeric nutrient criteria for many Class III waters in the state, including streams, which numerically interprets part of the state narrative criterion for nutrients. While those criteria have been submitted to EPA for review pursuant to section 303(c) of the CWA, EPA has not completed that review. Therefore, for streams in Florida, the applicable nutrient water quality standard for CWA purposes remains the Class III narrative criterion.

As set out more fully below, should any new or revised state criteria for nutrients in streams in Florida become applicable for CWA purposes before this proposed TMDL is established, EPA will consider the impact of such criteria on the target selected for this TMDL.

Also, in November 2010, EPA promulgated numeric nutrient criteria for Class III inland waters in Florida, including streams. On February 18, 2012, the streams criteria were invalidated by the U.S. District Court for the Northern District of Florida and remanded back to EPA. Should federally promulgated criteria become effective for CWA purposes before this proposed TMDL is established, EPA will consider the impact of such criteria on the target selected for this TMDL.

4.1.1. Narrative Nutrient Criteria

Florida's narrative nutrient criterion provides:

> The discharge of nutrients shall continue to be limited as needed to prevent violations of other standards contained in this chapter. Man induced nutrient enrichment (total nitrogen and total phosphorus) shall be considered degradation in relation to the provisions of Sections 62-302.300, 62-302.700, and 62-4.242. [Section 62-302.530(48)(a), F.A.C.]
>
> In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna. [Section 62-302.530(48)(b), F.A.C.]

Chlorophyll and dissolved oxygen (DO) levels are often used to indicate whether nutrients are present in excessive amounts. The target for this TMDL is based on levels of nutrients necessary to prevent violations of Florida's DO criterion, set out below.

4.1.2. Florida's adopted numeric nutrient criteria for streams

Florida's recently adopted numeric nutrient criteria interprets the narrative water quality criterion for nutrients in paragraph 62-302.530(48)(b), F.A.C. See section 62-302.531(2). The Florida rule provides that the narrative water quality criteria for nutrients in paragraph 62-302.530(47)(a), F.A.C., continues to apply to all Class III waters. See section 62-302.531(1).

Florida's recently adopted rule applies to streams, including WBID 3075. For streams that do not have a site specific criteria, Florida's rule provides for biological information to be considered together with nutrient thresholds to determine whether a waterbody is attaining 62-302.531(2)(c), F.A.C. The rule provides that the nutrient criteria are attained in a stream segment where information on chlorophyll a levels, algal mats or blooms, nuisance macrophyte growth, and changes in algal species composition indicates there are no imbalances in flora and either the average score of at least two temporally independent Stream Condition Indexes (SCIs) performed at representative locations and times is 40 or higher, with neither of the two most recent SCI scores less than 35, or the nutrient thresholds set forth in Table 1 below are achieved. See section 62-302.531(2)(c).

Florida's rule provides that numeric nutrient criteria are expressed as a geometric mean, and concentrations are not to be exceeded more than once in any three calendar year period. [Section 62-302.200 (25)(e), F.A.C.]

Should FDEP's numeric nutrient criteria for streams become an applicable water quality standard for CWA purposes before this TMDL is established, EPA will consider the nutrient target necessary to attain section 62-302.531(2)(c), F.A.C. EPA will compare that target with the target necessary to attain paragraph 62-302.530(47)(a), F.A.C., to determine which target is more stringent.

Table 1. Inland numeric nutrient criteria

Nutrient Watershed Region	Total Phosphorus Nutrient Threshold	Total Nitrogen Nutrient Threshold
Panhandle West	0.06 mg/L	0.67 mg/L
Panhandle East	0.18 mg/L	1.03 mg/L
North Central	0.30 mg/L	1.87 mg/L
Peninsular	0.12 mg/L	1.54 mg/L
West Central	0.49 mg/L	1.65 mg/L
South Florida	No numeric nutrient threshold. The narrative criterion in paragraph 62-302.530(47)(b), F.A.C., applies.	No numeric nutrient threshold. The narrative criterion in paragraph 62-302.530(47)(b), F.A.C., applies.

4.2. Dissolved Oxygen Criteria:

Numeric criteria for DO are expressed in terms of minimum and daily average concentrations. Section 62-302(30), F.A.C., sets out the water quality criterion for the protection of Class III freshwater waters as:

> Shall not be less than 5.0 mg/l. Normal daily and seasonal fluctuations above these levels shall be maintained.

4.3. Biochemical Oxygen Demand Criteria:

> Biochemical Oxygen Demand (BOD) shall not be increased to exceed values which would cause dissolved oxygen to be depressed below the limit established for each class and, in no case, shall it be great enough to produce nuisance conditions. [FAC 62-302.530 (11)]

4.4. Natural Conditions

In addition to the standards for nutrients, DO and BOD described above, Florida's standards include provisions that address waterbodies which do not meet the standards due to natural background conditions.

Florida's water quality standards provide a definition of natural background:

> "Natural Background" shall mean the condition of waters in the absence of man-induced alterations based on the best scientific information available to the

> Department. The establishment of natural background for an altered waterbody may be based upon a similar unaltered waterbody or on historical pre-alteration data. 62-302.200(15), FAC.

Florida's water quality standards also provide that:

Pollution which causes or contributes to new violations of water quality standards or to continuation of existing violations is harmful to the waters of this State and shall not be allowed. Waters having water quality below the criteria established for them shall be protected and enhanced. However, the Department shall not strive to abate natural conditions. [62-302.300(15) FAC]

5. Water Quality Assessment

WBID 3075 (Wolf Creek) was listed as not attaining its designated uses on Florida's 1998 303(d) list for DO and Nutrients. To determine impairment, an assessment of available data was conducted. The source for current ambient monitoring data for Wolf Creek was the IWR data Run 44. The IWR database contains data from various sources within the state of Florida, including the WMDs and counties.

5.1. Water Quality Data

The tables and figures below present the station locations and time series data for DO, total nitrogen, total phosphorus, BOD, and chlorophyll a observations for Wolf Creek.

5.1.1. Wolf Creek - WBID 3075

Table 2 provides a list of the water quality monitoring stations in the Wolf Creek WBID including the date range of the observations and the number of observations. Figure 6 illustrates where the IWR stations are located within the WBID.

Table 2. Water Quality Monitoring Stations for WBID: 3075 Wolf Creek

Station	Station Name	First Date	Last Date	No. Obs.
21FLBRA 3075-A	3075 - Wolf Creek - bridge on CR 419	6/26/2007 14:47	5/15/2008 11:20	36
21FLCEN 20010465	Wolf Creek at S.R. 419	3/3/2003 9:39	1/5/2010 10:23	90
21FLSJWMNWOLF	Wolf Creek at SR419 bridge	7/10/2002 9:30	3/31/2011 12:10	350
21FLCEN 20010829	Wolf Creek @ dirt road ~2.5 mi south of Gator Branch Rd	3/3/2003 10:14	9/22/2003 11:15	33

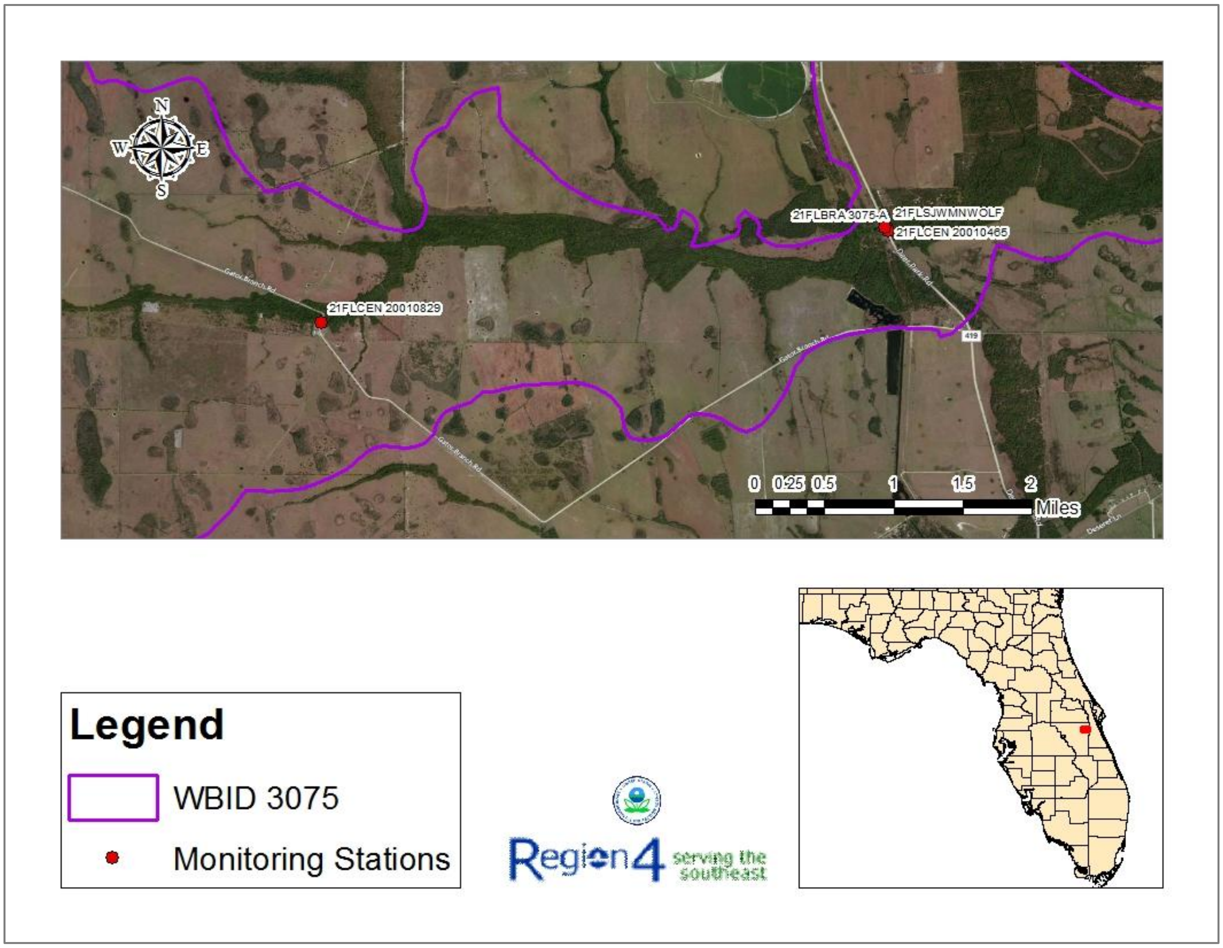

Figure 6. Station Locations for WBID 3075: Wolf Creek

Dissolved Oxygen

There are several factors that affect the concentration of DO in a waterbody. Oxygen can be introduced by wind, diffusion, photosynthesis, and additions of water with higher DO (e.g. from tributaries). DO concentrations are lowered by processes that use up oxygen from the water, such as respiration and decomposition, and by additions of water with lower DO (e.g. swamp or groundwater). Natural DO levels are a function of water temperature, water depth and velocity, and relative contributions of groundwater. Decomposition of organic matter, such as dead plants and animals, also uses up DO.

Figure 7 provides a time series plot for the measured DO concentrations in Wolf Creek. There were 4 monitoring stations used in the assessment that included a total of 138 observations of which 88 (64%) fell below the water quality standard of 5 mg/l DO. The minimum value was 0.11 mg/l, the maximum was 8.8 mg/l and the average was 4.4 mg/l.

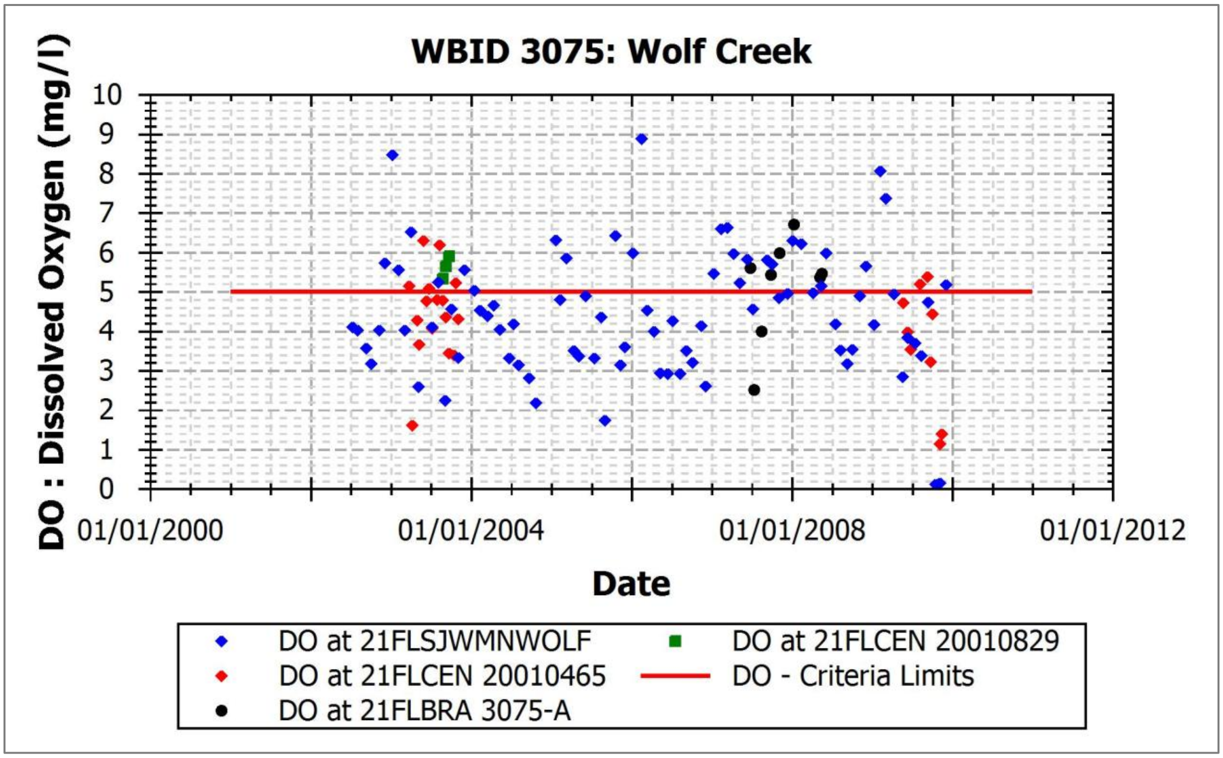

Figure 7. WBID 3075: Wolf Creek Measured DO

Biochemical Oxygen Demand

BOD is a measure of the amount of oxygen used by bacteria as they stabilize organic matter. Figure 8 provides a time series plot for the measured BOD concentrations in Wolf Creek. There were 3 monitoring stations used in the assessment that included a total of 18 observations. The minimum value was 2.0 mg/l, the maximum was 2.0 mg/l and the average was 2.0 mg/l.

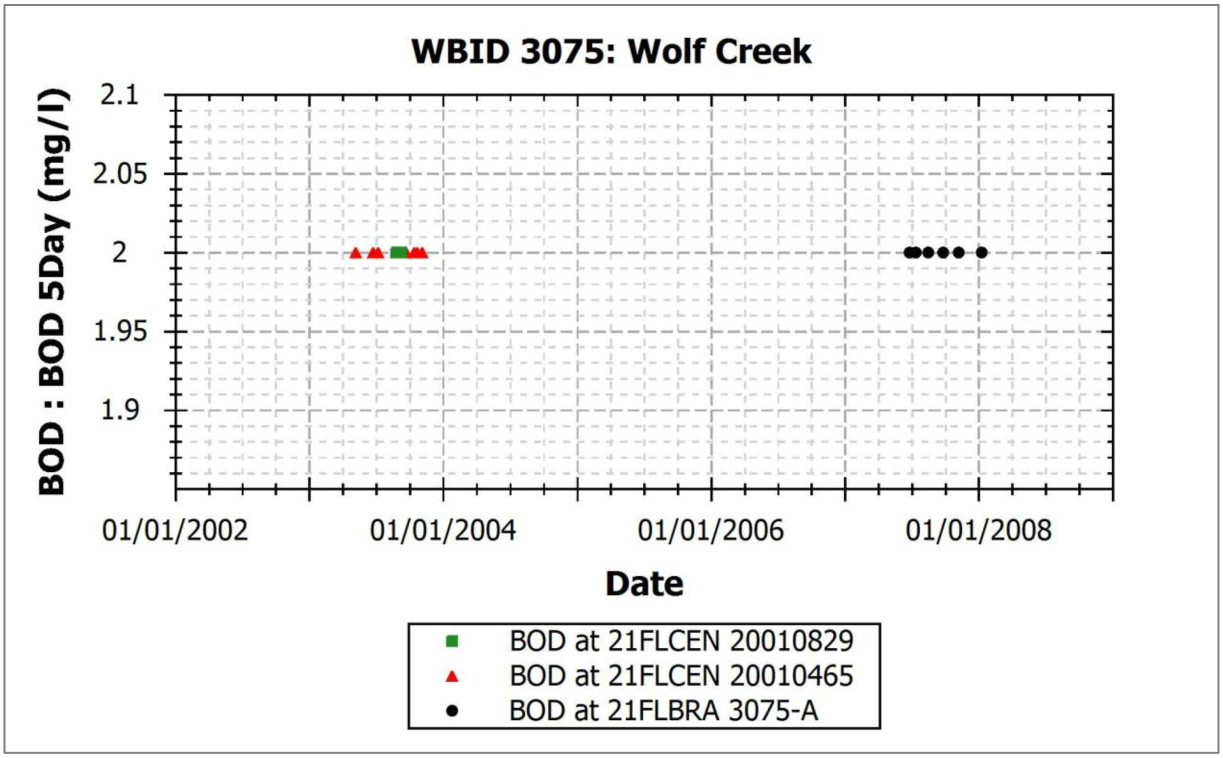

Figure 8. WBID 3075: Wolf Creek Measured BOD

Nutrients

Excessive nutrients in a waterbody can lead to overgrowth of algae and other aquatic plants such as phytoplankton, periphyton and macrophytes. This process can deplete oxygen in the water, adversely affecting aquatic life and potentially restricting recreational uses such as fishing and boating. For the nutrient assessment the monitoring data for total nitrogen, total phosphorus and chlorophyll a are presented. The current standards for nutrients are narrative criteria. The purpose of the nutrient assessment is to present the range, variability and average conditions for the WBID.

Total Nitrogen

Total Nitrogen (TN) is comprised of nitrate (NO3), nitrite (NO2), organic nitrogen and ammonia nitrogen (NH4). Figure 9 provides a time series plot for the measured TN concentrations in Wolf Creek. There were 4 monitoring stations used in the assessment that included a total of 125 observations. The minimum value was 0.56 mg/l, the maximum was 2.12 mg/l and the average was 1.09 mg/l.

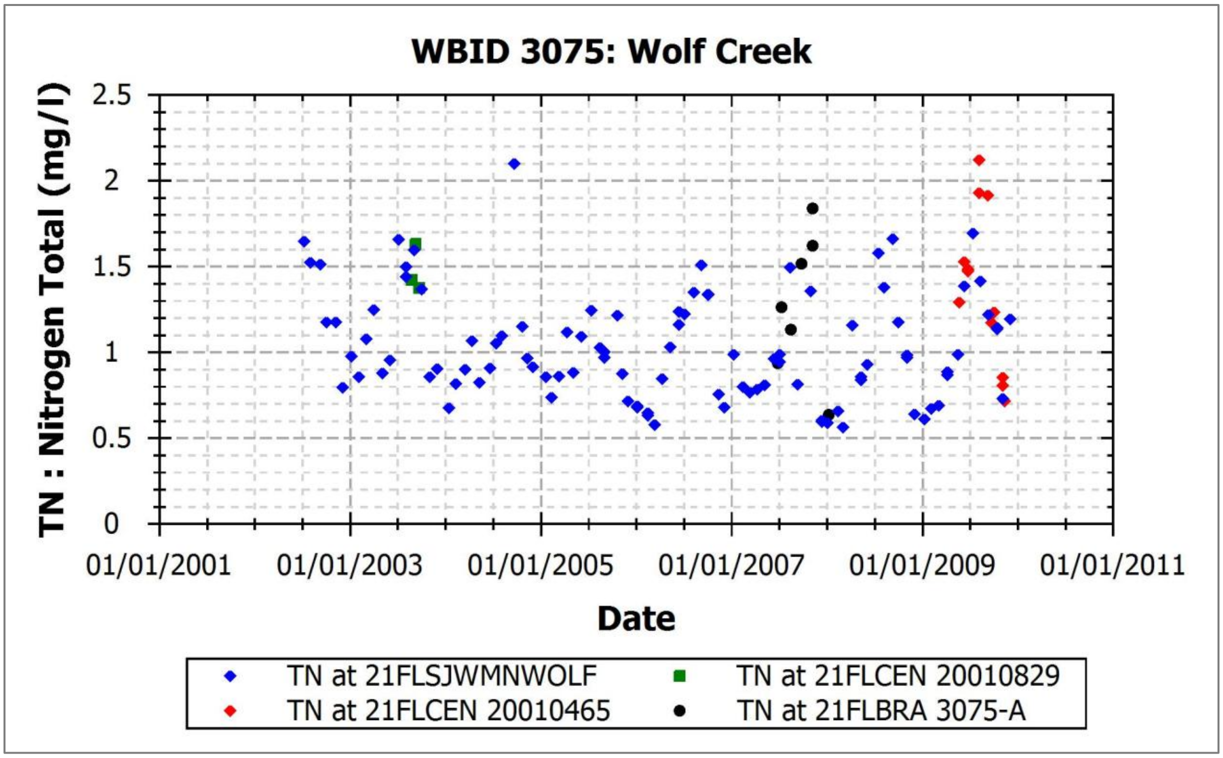

Figure 9. WBID 3075: Wolf Creek Measured Total Nitrogen

Total Phosphorus

In natural waters, total phosphorus exists in either soluble or particulate forms. Dissolved phosphorus includes inorganic and organic forms, while particulate phosphorus is made up of living and dead plankton, and adsorbed, amorphous, and precipitated forms. Inorganic forms of phosphorus include orthophosphate and polyphosphates, though polyphosphates are unstable and convert to orthophosphate over time. Orthophosphate is both stable and reactive, making it the form most used by plants. Excessive phosphorus can lead to overgrowth of algae and aquatic plants, the decomposition of which uses up oxygen from the water. Figure 10 provides a time series plot for the measured total phosphorus concentrations in Wolf Creek. There were 4 monitoring stations used in the assessment that included a total of 117 observations. The minimum value was 0.029 mg/l, the maximum was 0.35 mg/l and the average was 0.091 mg/l.

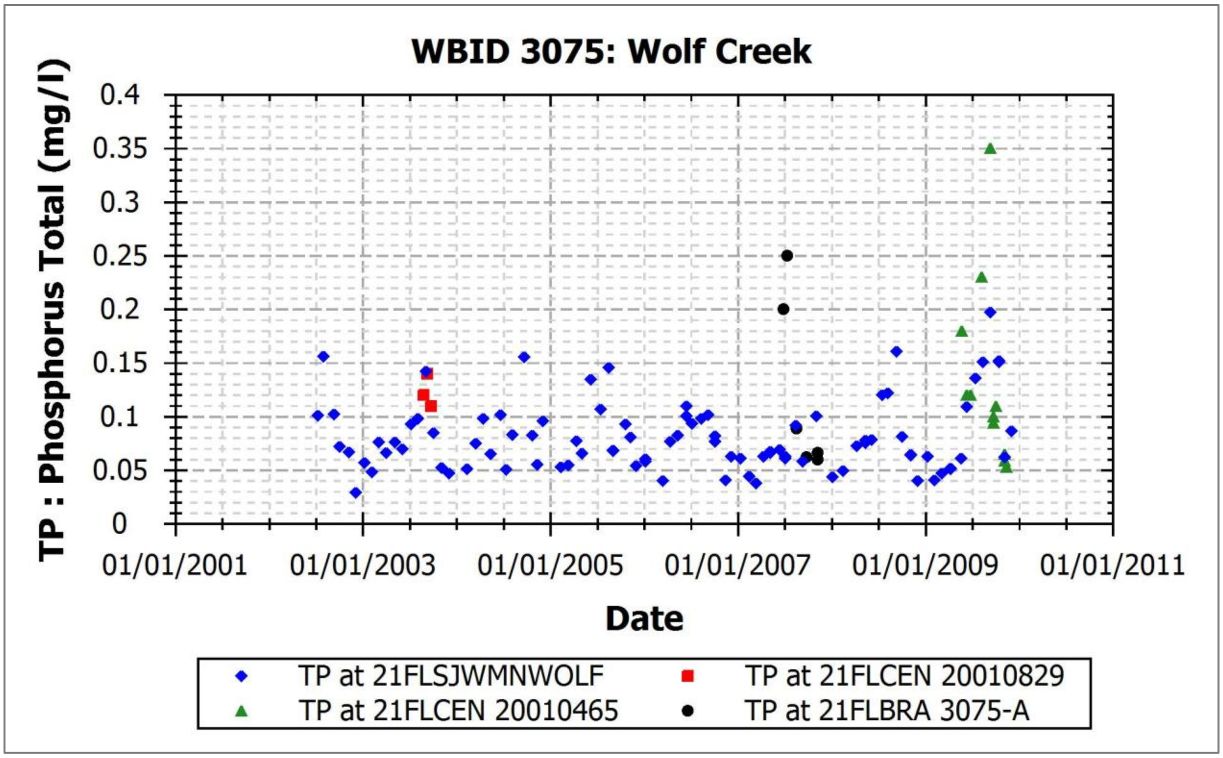

Figure 10. WBID 3075: Wolf Creek Measured Total Phosphorus

Chlorophyll a

Chlorophyll is the green pigment in plants that allows them to create energy from light. In a water sample, chlorophyll is indicative of the presence of algae, and chlorophyll-*a* is a measure of the active portion of total chlorophyll. Corrected chlorophyll refers to chlorophyll-*a* measurements that are corrected for the presence of pheophytin, a natural degradation product of chlorophyll that can interfere with analysis because it has an absorption peak in the same spectral region.

Figure 11 provides a time series plot for corrected chlorophyll a concentrations in Wolf Creek. There were 2 monitoring stations used in the assessment that included a total of 18 observations. The minimum value was 1.00 µg/l, the maximum was 14.0 µg/l and the average was 2.45 µg/l.

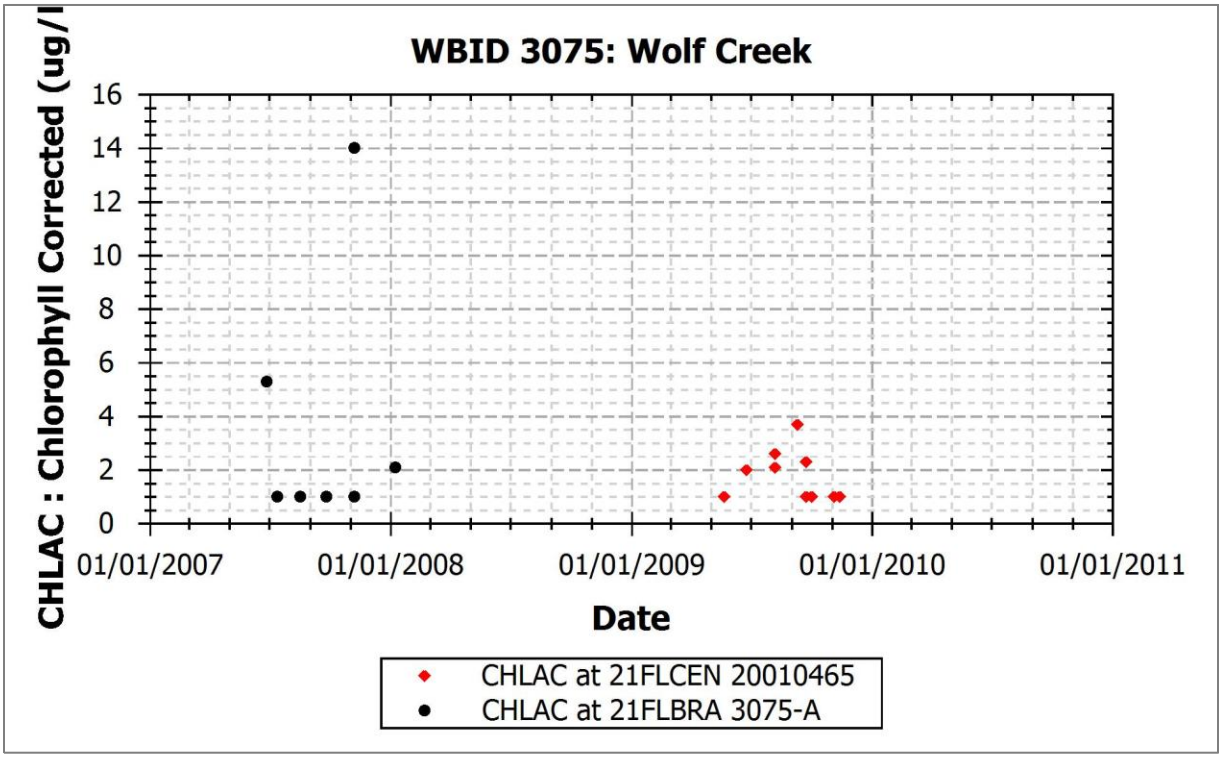

Figure 11. WBID 3075: Wolf Creek Measured Chlorophyll a Concentrations

6. Source and Load Assessment

An important part of the TMDL analysis is the identification of source categories, source subcategories, or individual sources of pollutants in the watershed and the amount of loading contributed by each of these sources. Sources are broadly classified as either point or nonpoint sources. Nutrients can enter surface waters from both point and nonpoint sources.

6.1. Point Sources

A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source discharges of industrial wastewater and treated sanitary wastewater must be authorized by National Pollutant Discharge Elimination System (NPDES) permits. NPDES permitted discharges include continuous discharges such as wastewater treatment facilities as well as some stormwater driven sources such as municipal separate storm sewer systems (MS4s), certain industrial facilities, and construction sites over one acre.

6.1.1. Wastewater/Industrial Permitted Facilities

A TMDL wasteload allocation (WLA) is given to wastewater and industrial NPDES permitted facilities discharging to surface waters within an impaired watershed. There are no NPDES-permitted facilities that discharge within the Wolf Creek watershed.

6.1.2. Stormwater Permitted Facilities/MS4s

MS4s are point sources also regulated by the NPDES program. According to 40 CFR 122.26(b)(8), an MS4 is "a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains):

> (i) Owned or operated by a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law)...including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the Clean Water Act that discharges into waters of the United States;
>
> (ii) Designed or used for collecting or conveying storm water;
>
> (iii) Which is not a combined sewer; and
>
> (iv) Which is not part of a Publicly Owned Treatment Works."

MS4s may discharge nutrients and other pollutants to waterbodies in response to storm events. In 1990, USEPA developed rules establishing Phase I of the NPDES stormwater program, designed to prevent harmful pollutants from being washed by stormwater runoff into MS4s (or from being dumped directly into the MS4) and then discharged from the MS4 into local waterbodies. Phase I of the program required operators of "medium" and "large" MS4s (those generally serving populations of 100,000 or greater) to implement a stormwater management program as a means to control polluted discharges from MS4s. Approved stormwater management programs for medium and large MS4s are required to address a variety of water quality related issues including roadway runoff management, municipal owned operations, hazardous waste treatment, etc.

Phase II of the rule extends coverage of the NPDES stormwater program to certain "small" MS4s. Small MS4s are defined as any MS4 that is not a medium or large MS4 covered by Phase I of the NPDES stormwater program. Only a select subset of small MS4s, referred to as "regulated small MS4s", requires an NPDES stormwater permit. Regulated small MS4s are defined as all small MS4s located in "urbanized areas" as defined by the Bureau of the Census, and those small MS4s located outside of "urbanized areas" that are designated by NPDES permitting authorities.

In October 2000, USEPA authorized FDEP to implement the NPDES stormwater program in all areas of Florida except Indian tribal lands. FDEP's authority to administer the NPDES program is set forth in Section 403.0885, Florida Statutes (FS). The three major components of NPDES stormwater regulations are:

• MS4 permits that are issued to entities that own and operate master stormwater systems, primarily local governments. Permittees are required to implement comprehensive stormwater management programs designed to reduce the discharge of pollutants from the MS4 to the maximum extent practicable.

• Stormwater associated with industrial activities, which is regulated primarily by a multisector general permit that covers various types of industrial facilities. Regulated industrial facilities must obtain NPDES stormwater permit coverage and implement appropriate pollution prevention techniques to reduce contamination of stormwater.

• Construction activity general permits for projects that ultimately disturb one or more acres of land and which require the implementation of stormwater pollution prevention plans to provide for erosion and sediment control during construction.

There are currently no permitted MS4 service areas within the Wolf Creek watershed. Any newly designated MS4s will be required to achieve the percent reduction allocation presented in this TMDL.

6.2. Nonpoint Sources

Nonpoint sources of pollution are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. For nutrients, these sources include runoff of agricultural fields, golf courses, and lawns, septic tanks, and residential developments outside of MS4 areas. Nonpoint source pollution generally involves a buildup of pollutants on the land surface that wash off during rain events and as such, represent contributions from diffuse sources, rather than from a defined outlet. Potential nonpoint sources are commonly identified, and their loads estimated, based on land cover data. Most methods calculate nonpoint source loadings as the product of the water quality concentration and runoff water volume associated with certain land use practices. The mean concentration of pollutants in the runoff from a storm event is known as the event mean concentration.

Figure 3 provides a map of the land use in the Wolf Creek watershed. Figure 4 provides the landuse distribution for the Wolf Creek watershed which contains WBID 3075. The predominant landuse draining directly to Wolf Creek is agriculture which consists of 78 percent of the watershed followed by wetlands consisting of 16 percent.

The following sections are organized by land use. Each section provides a description of the land use, the typical sources of nutrient loading (if applicable), and typical total nitrogen and total phosphorus event mean concentrations.

6.2.1. Urban Areas

Urban areas include land uses such as residential, industrial, extractive and commercial. Land uses in this category typically have somewhat high total nitrogen event mean concentrations and average total phosphorus event mean concentrations. Nutrient loading from MS4 and non-MS4 urban areas is attributable to multiple sources including stormwater runoff, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals.

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as outlined in Chapter 403 FS, was established as a technology-based program that relies upon the implementation of Best Management Practices (BMPs) that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, FAC.

Florida's stormwater program is unique in having a performance standard for older stormwater systems that were built before the implementation of the Stormwater Rule in 1982. This rule states: "the pollutant loading from older stormwater management systems shall be reduced as needed to restore or maintain the beneficial uses of water." [FAC 62-40-.432(2)(c)]

Nonstructural and structural BMPs are an integral part of the State's stormwater programs. Nonstructural BMPs, often referred to as "source controls", are those that can be used to prevent the generation of nonpoint source pollutants or to limit their transport off-site. Typical nonstructural BMPs include public education, land use management, preservation of wetlands and floodplains, and minimization of impervious surfaces. Technology-based structural BMPs are used to mitigate the increased stormwater peak discharge rate, volume, and pollutant loadings that accompany urbanization.

Urban, residential, and commercial developments are potential nonpoint sources of nutrients and oxygen-demanding substances in the Wolf Creek watershed. However, it is unlikely to be predominant source since landuses in this category comprise of less than one percent of the watershed area and consist of only low density residential properties.

Onsite Sewage Treatment and Disposal Systems (Septic Tanks)

As stated above leaking septic tanks or onsite sewage treatment and disposal systems (OSTDs) can contribute to nutrient loading in urban areas. Water from OSTDs is typically released to the ground through on-site, subsurface drain fields or boreholes that allow the water from the tank to percolate (usually into the surficial aquifers) and either transpire to the atmosphere through surface vegetation or add to the flow of shallow ground water. When properly sited, designed, constructed, maintained, and operated, OSTDs are a safe means of disposing of domestic waste. The effluent from a well-functioning OSTD receives natural biological treatment in the soil and is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, OSTDs can be a source of nutrients, pathogens, and other pollutants to both ground water and surface water.

The State of Florida Department of Health publishes data on new septic tank installations and the number of septic tank repair permits issued for each county in Florida. Table 3 summarizes the cumulative number of septic systems installed since the 1970 census and the total number of repair permits issued for the ten years between 1991-92 and 2009-10. The data do not reflect septic tanks removed from service.

Table 3. County Estimates of Septic Tanks and Repair Permits

County	Number of Septic Tanks (1970- 2010)	Number of Repair Permits Issued (1991-2010)
Osceola	24,715	2,716

Note: Source: http://www.doh.state.fl.us/environment/ostds/statistics/ostdsstatistics.htm

The State of Florida Department of Health also maintains a list of OSTDs that have been inspected by the Florida Department of Health. The purpose for the inspections range from new installations to requested repair work. Figure 12 depicts the OSTDs inspection conducted in and adjacent to WBID 3075, Wolf Creek. Without additional information, an explicit source cannot be determined. However, the presence of at least one OSTD in the Wolf Creek watershed suggests that OSTDs could potentially be a source of nutrient and oxygen-demanding substances to the watershed.

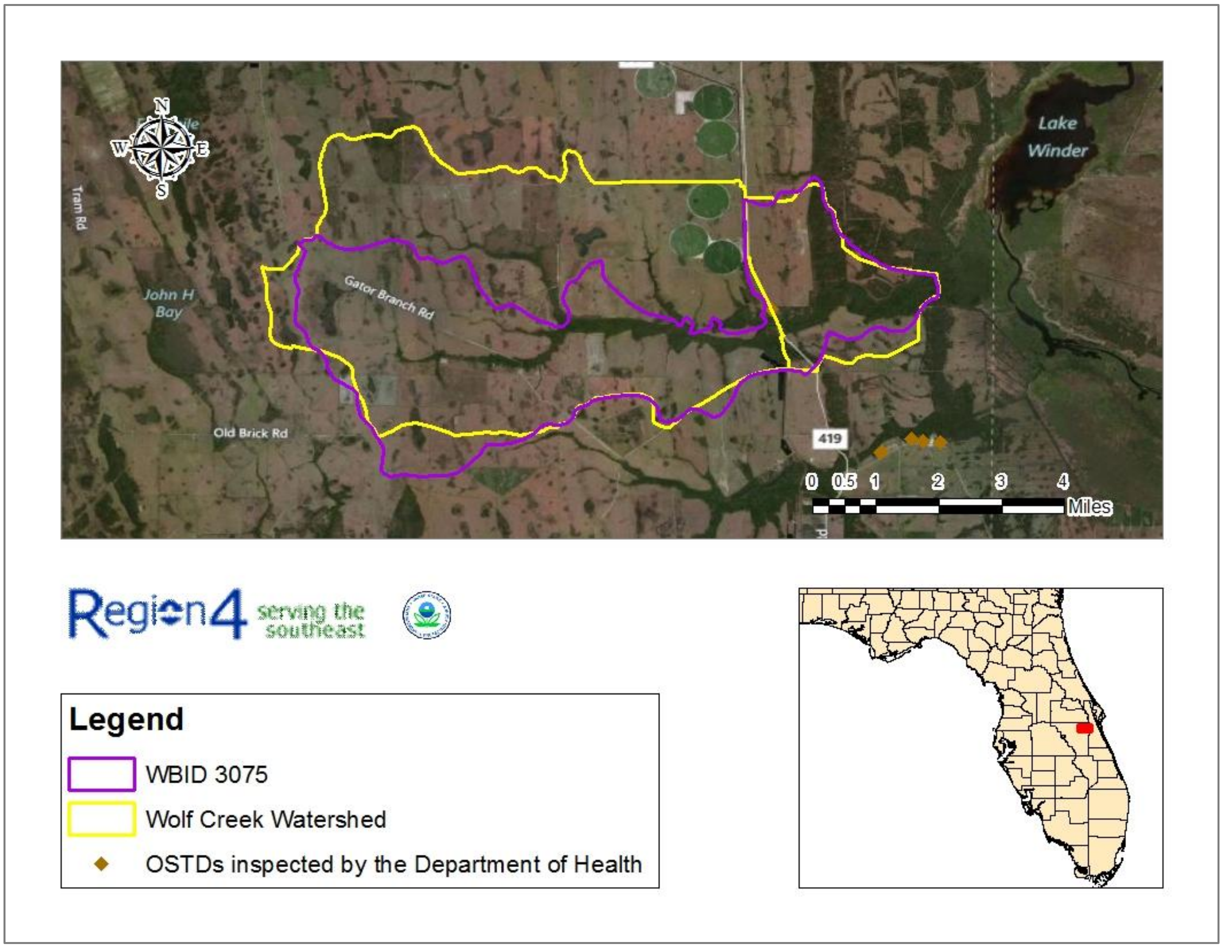

Figure 12. OSTDs inspected in the vicinity of Wolf Creek, WBID 3075

6.2.2. Agriculture

Agricultural lands include improved and unimproved pasture, row and field crops, tree crops, nurseries, and specialty farms. Agricultural activities, including runoff of fertilizers or animal wastes from pasture and cropland and direct animal access to streams, can generate nutrient loading to streams. The highest total nitrogen and total phosphorus event mean concentrations are associated with agricultural land uses.

The USDA National Agricultural Statistics Service (NASS) compiles Census of Agriculture data by county for virtually every facet of U.S. agriculture (USDA NASS, 2007). According to 2007 Census of Agriculture data, there were 181 farms which fertilized approximately 76,782 acres with commercial fertilizer, lime and soil conditioners in Osceola County, Florida. The census also shows that approximately 3,560 acres of 15 farms were fertilized with manure in 2002 (2007 data was not available). Livestock counts of cattle and pigs for Osceola County are provided in Table 4. Because agricultural census data are collected at the county level, the extent to which these values pertain to agricultural fields within the impaired watershed is not specified.

Table 4. 2007 Agricultural Census Data for Livestock in Osceola County, Florida

County	Livestock	Number of Farms	Number of Animals
Osceola	Cattle and Calves	217	102,116
	Hogs and Pigs	21	45

Note: 1. A farm is defined as any place from which $1,000 or more of agricultural products were produced and sold, or normally would have been sold, during the census year.

Landuse data for the watershed shows that Wolf Creek and its headwaters are surrounded by agriculture. Approximately 78 percent of the watershed is used as agriculture, of which 69 percent is comprised of pastures and approximately nine percent of cropland. As such, agricultural uses could be a relevant source of nutrient loading to Wolf Creek.

6.2.3. Rangeland

Rangeland includes herbaceous, scrub, disturbed scrub and coastal scrub areas. Event mean concentrations for rangeland are about average for total nitrogen and low for total phosphorus. Rangeland comprises approximately two percent of the land use in the Wolf Creek watershed.

6.2.4. Upland Forests

Upland forests include flatwoods, oak, various types of hardwoods, conifers and tree plantations. Generally, the pollutant load from wildlife (including both animals and plants) is assumed to represent background concentrations. Event mean concentrations for upland forests are low for both total nitrogen and total phosphorus. Upland Forests consist of approximately four percent of the land use in the Wolf Creek watershed.

6.2.5. Water and Wetlands

Water and wetlands have very low event mean concentrations down to zero and comprise 16 percent of the land use in the Wolf Creek watershed.

6.2.6. Transportation, Communications and Utilities

Transportation uses include airports, roads and railroads. Event mean concentrations for these types of uses are in the mid-range for total nitrogen and total phosphorus. This landuse, which can represent a type of impervious landuse, comprise less than one present in the Wolf Creek watershed.

7. Analytical Approach

In the development of a TMDL there needs to be a method for relating current loadings to the observed water quality problem. This relationship could be: statistical (regression for a cause and effect relationship), empirical (based on observations not necessarily from the waterbody in question) or mechanistic (physically and/or stochastically based) that inherently relate cause and effect using physical and biological relationships.

Two mechanistic models were used in the development of this TMDL. The first model is a dynamic watershed model that predicts the quantity of water and pollutants that are associated with runoff from rain events. The second model is a dynamic water quality model that is capable of integrating the loadings from the watershed model to predict the water quality in the receiving waterbody.

The period of simulation that was considered in the development of this TMDL is January 1, 1999 to January 1, 2009. The models were used to predict time series for total nitrogen, total phosphorus, BOD, dissolved oxygen, and chlorophyll a. The models were calibrated to current conditions and were then used to predict improvements in water quality as function of reductions in loadings.

More details on the model application in the development of the Wolf Creek TMDL are presented in Appendix A.

7.1. Loading Simulation Program C++ (LSPC)

LSPC is the Loading Simulation Program in C++, a watershed modeling system that includes streamlined Hydrologic Simulation Program Fortran (HSPF) algorithms for simulating hydrology, sediment, and general water quality overland as well as a simplified stream fate and transport model. LSPC is derived from the Mining Data Analysis System (MDAS), which was originally developed by USEPA Region 3 (under contract with Tetra Tech) and has been widely used for TMDL development. In 2003, the USEPA Region 4 contracted with Tetra Tech to refine, streamline, and produce user documentation for the model for public distribution. LSPC was developed to serve as the primary watershed model for the USEPA TMDL Modeling Toolbox.

LSPC was used to simulate runoff (flow, total nitrogen, total phosphorus and BOD) from the land surface using a daily timestep for current and natural conditions of the Wolf Creek watershed. The predicted timeseries were used as boundary conditions for the receiving waterbody model to predict in-stream and in-lake water quality.

7.2. Water Quality Analysis Simulation Program (WASP)

The Water Quality Analysis Simulation Program (WASP) is a dynamic compartment-modeling program for aquatic systems, including both the water column and the underlying benthos. The time-varying processes of advection, dispersion, point and diffuse mass loading and boundary exchange are represented in the basic program. The conventional pollutant model within the WASP framework is capable of predicting time varying concentrations for chlorophyll a, dissolved oxygen, nutrients (nitrogen, phosphorus) as function of loadings, flows, and environmental conditions.

WASP was calibrated to the current conditions of the Wolf Creek watershed using known meteorology, predicted loadings from the LSPC model and constrained by observed data in Wolf Creek. Furthermore, WASP was used in determining the load reductions that would be needed to achieve the water quality standards and nutrient targets for Wolf Creek.

7.3. Scenarios

Several modeling scenarios were developed and evaluated in this TMDL determination. A full description of each of these scenarios is presented in Appendix A.

7.3.1. Current Condition

The first scenario is to model the current conditions of the watershed. This included the development of a watershed and water quality model. The watershed model is parameterized using the current landuses and measured meteorological conditions to predict the current loadings of nitrogen, phosphorus and BOD. These predicted loadings and flow time series are passed on to the water quality model where the predicted algal, nitrogen, phosphorus, BOD and DO concentrations are predicted over time. The models (watershed and water quality) are calibrated to an eleven year period of time to take into account varying environmental, meteorological or hydrological conditions on water quality. The existing condition annual average concentrations are presented in Table 5.

Table 5. Existing Condition Annual Average Model Predictions

Constituent	Existing
BOD (mg/L)	1.85
Chlorophyll a (ug/L)	3.26
DO (mg/L)	4.57
Total Nitrogen (mg/L)	1.16
Total Phosphorus (mg/L)	0.08

The current condition simulation will be used to determine the base loadings for Wolf Creek. These base loadings (Table 6) compared with the TMDL scenario will be used to determine the percent reduction in nutrient loads that will be needed to achieve water quality standards.

Table 6. Wolf Creek Existing Nutrient Loads (1999-2009)

	Current Condition	
Constituent	WLA (kg/yr)	LA (kg/yr)
BOD	NA	58,132
Total Nitrogen	NA	34,062
Total Phosphorus	NA	3,182

7.3.2. Natural Condition

The natural condition scenario is developed to estimate what water quality conditions would exist if there were little to no impact from anthropogenic sources. There are no point source dischargers in the Wolf Creek watershed. For the purpose of this analysis any landuse that is associated with man induced activities (urban, agriculture, transportation, barren lands and rangeland) is converted to upland forests and wetlands (50/50 split) and the associated event mean concentration for nitrogen, phosphorus and BOD are used. These natural condition loadings from the watershed model are passed onto the water quality model where natural water quality conditions are predicted. The natural condition water quality predictions are presented in Table 7.

Table 7. Natural Condition Annual Average Model Predictions

Constituent	Natural
BOD (mg/L)	1.16
Chlorophyll a (ug/L)	2.78
DO (mg/L)	5.62
Total Nitrogen (mg/L)	0.59
Total Phosphorus (mg/L)	0.05

The purpose of the natural conditions scenario is to determine whether water quality standards can be achieved without abating the naturally occurring loads from the watershed. The DO standard is not achievable under natural conditions. Therefore, the TMDL determination will set the allowable loads to the natural condition scenario.

Table 8 provides the natural condition's annual average load predictions for total nitrogen, total phosphorus, and BOD.

Table 8. Natural Condition Annual Average Nutrient

Natural Condition		
Constituent	WLA (kg/yr)	LA (kg/yr)
BOD	NA	34,230
Total Nitrogen	NA	18,714
Total Phosphorus	NA	886

Figure 13 provides a time series of DO concentrations under natural conditions. The model predicts that even under natural conditions the DO criteria will be exceeded.

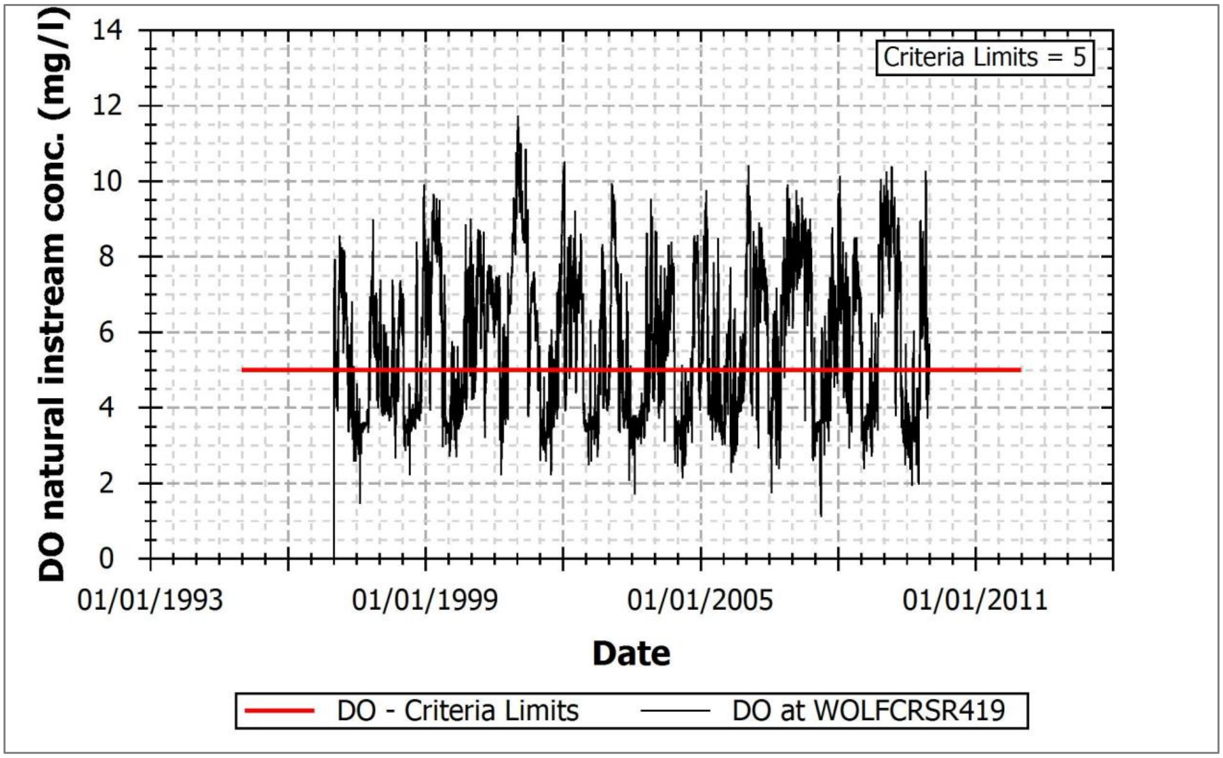

Figure 13. DO Concentration Time Series under Natural Condition

Figure 14 provides a cumulative distribution function of the DO concentrations under natural conditions.

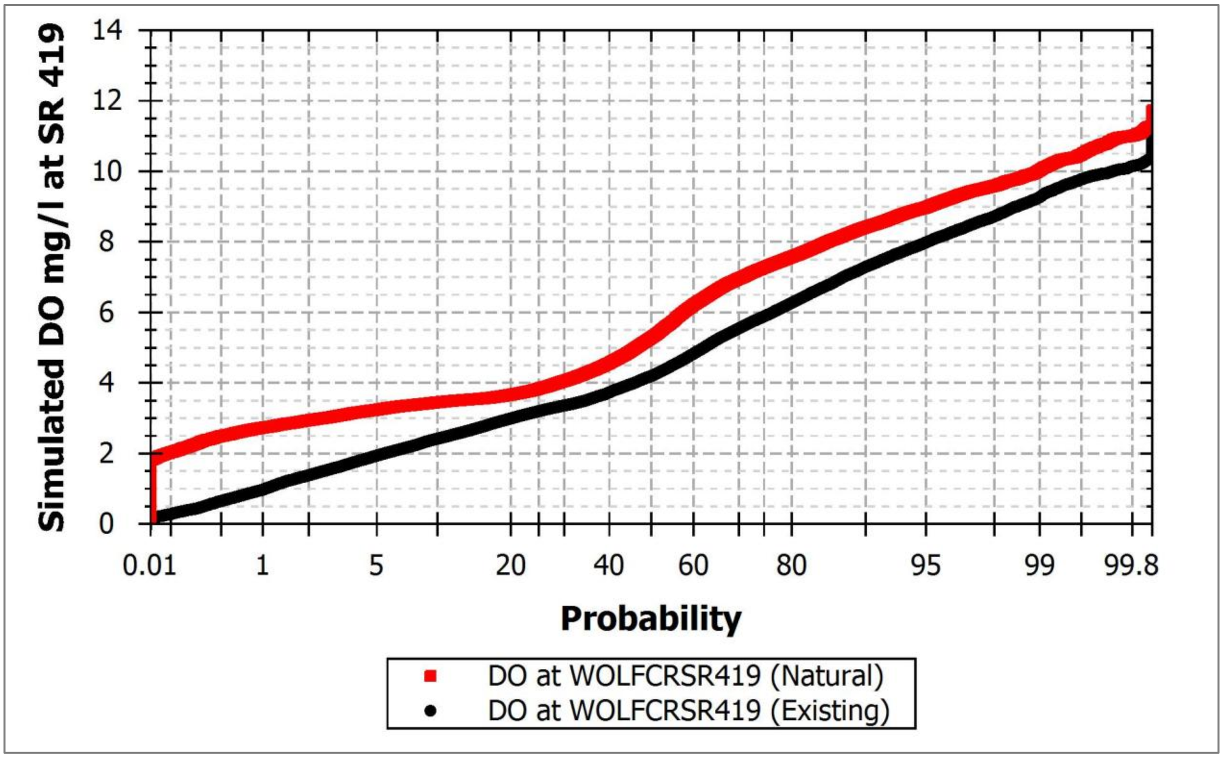

Figure 14. DO Concentration Cumulative Distribution Function under Natural Condition

8. TMDL Determination

The TMDL for a given pollutant and waterbody is comprised of the sum of individual WLAs for point sources, and load allocations (LAs) for both nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is represented by the equation:

$$\text{TMDL} = \sum \text{WLAs} + \sum \text{LAs} + \text{MOS}$$

The TMDL is the total amount of pollutant that can be assimilated by the receiving waterbody and still achieve water quality standards and the waterbody's designated use. In TMDL development, allowable loadings from all pollutant sources that cumulatively amount to no more than the TMDL must be set and thereby provide the basis to establish water quality-based controls. These TMDLs are expressed as annual mass loads, since the approach used to determine the TMDL targets relied on annual loadings. The TMDLs targets were determined to be the conditions needed to restore and maintain a balanced aquatic system. Furthermore, it is important to consider nutrient loading over time, since nutrients can accumulate in waterbodies.

During the development of this TMDL, it was determined that the natural condition scenario (removal of all anthropogenic sources and landuses) does not meet the Florida standards for

DO. The reductions prescribed in this TMDL reduce the current loadings to the natural condition in order to not abate a natural condition.

The TMDL was determined for the loadings coming from the upstream watershed and watershed that directly drains to Wolf Creek. The allocations are given in Table 9.

Table 9. TMDL Load Allocations for Wolf Creek

	Current Condition		TMDL Condition		MS4	LA
Constituent	WLA (kg/yr)	LA (kg/yr)	WLA (kg/yr)	LA (kg/yr)	% Reduction	% Reduction
BOD	NA	58,132	NA	34,230	NA	41%
Total Nitrogen	NA	34,062	NA	18,714	NA	45%
Total Phosphorus	NA	3,182	NA	886	NA	72%

8.1. Critical Conditions and Seasonal Variation

EPA regulations at 40 CFR 130.7(c)(1) require TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. The critical condition is the combination of environmental factors creating the "worst case" scenario of water quality conditions in the waterbody. By achieving the water quality standards at critical conditions, it is expected that water quality standards should be achieved during all other times. Seasonal variation must also be considered to ensure that water quality standards will be met during all seasons of the year, and that the TMDLs account for any seasonal change in flow or pollutant discharges, and any applicable water quality criteria or designated uses (such as swimming) that are expressed on a seasonal basis.

The critical condition for nonpoint source loadings and wet weather point source loadings is typically an extended dry period followed by a rainfall runoff event. During the dry weather period, nutrients build up on the land surface, and are washed off by rainfall. The critical condition for continuous point source loading typically occurs during periods of low stream flow when dilution is minimized. Although loading of nonpoint source pollutants contributing to a nutrient impairment may occur during a runoff event, the expression of that nutrient impairment is more likely to occur during warmer months, and at times when the waterbody is poorly flushed. Because of the eleven year simulation period used in the model development, the model encompasses both critical and seasonal variations to determine the annual average allowable load.

8.2. Margin of Safety

The MOS accounts for uncertainty in the relationship between a pollutant load and the resultant condition of the waterbody. There are two methods for incorporating an MOS into TMDLs (USEPA, 1991):

- Implicitly incorporate the MOS using conservative model assumptions to develop allocations

- Explicitly specify a portion of the total TMDL as the MOS and use the remainder for Allocations

This TMDL uses an implicit MOS since the TMDL targets for nutrients were set to natural background conditions.

8.3. Waste Load Allocations

Only MS4s and NPDES facilities discharging directly into lake segments (or upstream tributaries of those segments) are assigned a WLA. The WLAs, if applicable, are expressed separately for continuous discharge facilities (e.g., WWTPs) and MS4 areas, as the former discharges during all weather conditions whereas the later discharges in response to storm events.

8.3.1. Wastewater/Industrial Permitted Facilities

There is no continuous discharge NPDES permitted point sources in the Wolf Creek Watershed; therefore, no WLA was calculated.

8.3.2. Municipal Separate Storm Sewer System Permits

The WLA for MS4s are expressed in terms of percent reductions equivalent to the reductions required for nonpoint sources. Given the available data, it is not possible to estimate loadings coming exclusively from the MS4 areas. Although the aggregate wasteload allocations for stormwater discharges are expressed in numeric form, i.e., percent reduction, based on the information available today, it is infeasible to calculate numeric WLAs for individual stormwater outfalls because discharges from these sources can be highly intermittent, are usually characterized by very high flows occurring over relatively short time intervals, and carry a variety of pollutants whose nature and extent varies according to geography and local land use. For example, municipal sources such as those covered by this TMDL often include numerous individual outfalls spread over large areas. Water quality impacts, in turn, also depend on a wide range of factors, including the magnitude and duration of rainfall events, the time period between events, soil conditions, fraction of land that is impervious to rainfall, other land use activities, and the ratio of stormwater discharge to receiving water flow.

This TMDL assumes for the reasons stated above that it is infeasible to calculate numeric water quality-based effluent limitations for stormwater discharges. Therefore, in the absence of information presented to the permitting authority showing otherwise, this TMDL assumes that water quality-based effluent limitations for stormwater sources of nutrients derived from this TMDL can be expressed in narrative form (e.g., as best management practices), provided that: (1) the permitting authority explains in the permit fact sheet the reasons it expects the chosen BMPs to achieve the aggregate wasteload allocation for these stormwater discharges; and (2) the state will perform ambient water quality monitoring for nutrients for the purpose of determining whether the BMPs in fact are achieving such aggregate wasteload allocation.

All Phase 1 MS4 permits issued in Florida include a re-opener clause allowing permit revisions for implementing TMDLs once they are formally adopted by rule. Florida may designate an area as a regulated Phase II MS4 in accordance with Rule 62-620.800, FAC. Florida's Phase II MS4 Generic Permit has a "self-implementing" provision that requires MS4 permittees to update their stormwater management program as needed to meet their TMDL allocations once those TMDLs are adopted. Permitted MS4s will be responsible for reducing only the loads associated with stormwater outfalls which it owns, manages, or otherwise has responsible control. MS4s are not responsible for reducing other nonpoint source loads within its jurisdiction. There are currently no MS4s permitted within the Wolf Creek watershed. All future MS4s permitted in the area will be automatically prescribed a WLA equivalent to the percent reduction assigned to the LA.

8.4. Load Allocations

The load allocation for nonpoint sources was assigned a percent reduction in BOD and nutrient loadings from the current loadings coming into Wolf Creek (See Table 9).

9. Recommendations/Implementation

This TMDL is based on mechanistic modeling of the dissolved oxygen and eutrophication processes using available meteorologic data, hydrologic data, stream geometry, water chemistry data and the evidence of low reaeration, high detrital loading, strong photosynthetic activity, and strong Sediment Oxygen Demand (SOD). The lack of SOD measurements, reaeration measurements, aquatic macrophyte and periphyton measurements introduces uncertainty into this TMDL. Collection of these additional data will help reduce uncertainty and better assess the contribution of potential sources, the timing of any water quality exceedances, and necessary reductions.

The initial step in implementing a TMDL is to more specifically locate pollutant source(s) in the watershed. FDEP employs the Basin Management Action Plan (B-MAP) as the mechanism for developing strategies to accomplish the specified load reductions. Components of a B-MAP are:

- Allocations among stakeholders
- Listing of specific activities to achieve reductions
- Project initiation and completion timeliness
- Identification of funding opportunities
- Agreements
- Local ordinances
- Local water quality standards and permits
- Follow-up monitoring

10. References

Florida Administrative Code. Chapter 62-40, Water Resource Implementation Rule.

Florida Administrative Code. Chapter 62-302, Surface Water Quality Standards.

Florida Administrative Code. Chapter 62-303, Identification of Impaired Surface Waters.

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